POWER SUPPLY DEVICE

FIELD OF THE INVENTION

The present invention relates to a power supply device for supplying electric power to an information processor, such as a server, and more particularly to a power supply device in which a parallel redundancy structure is adopted.

BACKGROUND OF THE INVENTION

Recently, according to the massive spread of the Internet, high reliability and cost performance are required for an information processor, such as a server, that forms the core of the Internet. Here, the reliability and the cost of an information processor are largely influenced by the reliability of the power supply device by which electric power is supplied to the information processor. Thus, high reliability and cost performance are required also for the power supply device.

Fig. 5 is a block diagram showing the structure of a power supply 10 in the prior art. The power supply 10 shown in this drawing is mounted in an information processor (whose drawing is omitted), such as a server, converts an AC voltage source V_{AC} into a DC voltage supply V_{DC}, and supplies this DC voltage supply V_{DC} to a load 20. As this load 20, a printed board circuit mounted in an information processor, a magnetic disk unit, or

the like are given.

The power supply 10 is provided with n power supply units 11_1 to 11_n. Respective these power supply units 11_1 to 11_n are identically constituted wherein a parallel redundancy structure is adopted so that even when the DC voltage supply output of at least one power supply unit is stopped, the load 20 is not influenced by other power supply units. These power supply units 11_1 to 11_n are inserted into plural slots provided inside the information processor, respectively, and are provided with a function by which hot-line maintenance can be executed without stopping the supply of the DC voltage supply to the load 20.

The power supply unit 11_1 is inserted between a feeder terminal TA_1 and the load 20, converts the AC voltage source V_{AC} supplied to the feeder terminal TA_1 into a DC voltage supply V_{DC1}, and supplies this DC voltage supply V_{DC1} to the load 20. In the power supply unit 11_1, a main power supply unit 12_1 is provided with an AC/DC (Alternating Current/Direct Current) converting function and converts the AC voltage source V_{AC} into the DC voltage supply V_{DC1}. The main power supply unit 12_1 supplies the DC voltage supply V_{DC1} to the load 20 via a power supply cable (whose drawing is omitted).

A main power supply control section 13_1 is provided in the main power supply unit 12_1 and performs an ON/OFF control of the AC/DC converting function and abnormality monitoring

of the main power supply unit 12_1. When abnormality occurs in the main power supply unit 12_1, the main power supply control section 13_1 transmits an abnormality detection signal to a unit side control section 17_1. A diode 14_1 is an element provided in the downstream side of the main power supply unit 12_1 and preventing a rush current from flowing in the main power supply unit 12_1 when the power supply unit 11_1 is inserted in the slot of the information processor. A control power supply unit 15_1 is inserted between the feeder terminal TA_1 and a main control section 30 and converts the AC voltage source V_{AC} supplied to the feeder terminal TA_1 into a DC voltage supply V_{A1}, a DC voltage supply V_{B1}, and a DC voltage supply V_{C1}.

The control power supply unit 15_1 supplies the DC voltage supply V_{A1} to the main power supply control section 13_1, the DC voltage supply V_{B1} to the unit side control section 17_1, and the DC voltage supply V_{C1} to a DC/DC converting section 31 of the main control section 30, respectively. That is, in the power supply units 11_1, the control power supply unit 15_1 supplying the DC voltage supply to a control system including the main power supply control section 13_1, the unit side control section 17_1, and the main control section 30 (the DC/DC converting section 31) is provided, separated from the main power supply unit 12_1. As the control power supply unit 15_1, the one provided with a DC/DC converting function for converting the DC voltage supply V_{DC} from the main power supply

unit 12_1 into a predetermined value of DC voltage supply may also be employed.

A diode 16_1 is an element provided in the downstream side of the control power supply unit 15_1 and preventing a rush current from flowing in the control power supply unit 15_1 when the power supply unit 11_1 is inserted in the slot of the information processor. The unit side control section 17_1 is connected to the main control section 30 via an interface 18_1 and works as a communication interface between the main power supply control section 13_1 and the main control section 30.

Concretely, the unit side control section 17_1 has the function by which an ON/OFF control signal from the main control section 30 is received via the interface 18_1 and is transmitted to the main power supply control section 13_1 and the function by which an abnormality detection signal from the main power supply control section 13_1 is received and is transmitted to the main control section 30 via the interface 18_1.

The power supply units 11_n of the number n is inserted between a feeder terminal TA_n and the load 20, converts the AC voltage source V_{AC} supplied to the feeder terminal TA_n into a DC voltage supply V_{DCn}, and supplies this DC voltage supply V_{DCn} to the load 20. In the power supply unit 11_n, a main power supply unit 12_n is identically constituted with the main power supply unit 12_1 and converts the AC voltage source V_{AC} into the

DC voltage supply V_{DCn}. A main power supply unit 12_n supplies the DC voltage supply V_{DCn} to the load 20 via a power supply cable (whose drawing is omitted).

A main power supply control section 13_n is provided in the main power supply unit 12_n and performs an ON/OFF control of the AC/DC converting function and abnormality monitoring of the main power supply unit 12_n. When abnormality occurs in the main power supply unit 12_n, the main power supply control section 13_n transmits an abnormality detection signal to a unit side control section 17_n. A diode 14_n is an element provided in the downstream side of the main power supply unit 12_n and preventing a rush current from flowing in the main power supply unit 12_n when the power supply unit 11_n is inserted in the slot of the information processor. A control power supply unit 15_n is inserted between the feeder terminal TA_n and the main control section 30 and converts the AC voltage source V_{AC} supplied to the feeder terminal TA_n into a DC voltage supply V_{An}, a DC voltage supply V_{Bn}, and a DC voltage supply V_{Cn}.

The control power supply unit 15_n supplies the DC voltage supply V_{An} to the main power supply control section 13_n, the DC voltage supply V_{Bn} to the unit side control section 17_n, and the DC voltage supply V_{Cn} to the DC/DC converting section 31 of the main control section 30, respectively. That is, in the power supply units 11_n, the control power supply unit 15_n supplying the DC voltage supply to a control system including

the main power supply control section 13_n, the unit side control section 17_n, and the main control section 30 (the DC/DC converting section 31) is provided, separated from the main power supply unit 12_n, similarly to the power supply units 11_1.

A diode 16_n is an element provided in the downstream side of the control power supply unit 15_n and preventing a rush current from flowing in the control power supply unit 15_n when the power supply unit 11_n is inserted in the slot of the information processor. The unit side control section 17_n is connected to the main control section 30 via an interface 18_n and works as a communication interface between the main power supply control section 13_n and the main control section 30.

Concretely, the unit side control section 17_n has the function by which an ON/OFF control signal from the main control section 30 is received via the interface 18_n and is transmitted to the main power supply control section 13_n and the function by which an abnormality detection signal from the main power supply control section 13_n is received and is transmitted to the main control section 30 via the interface 18_n.

The main control section 30 is connected to the unit side control sections 17_1 to 17_n via the interfaces 18_1 to 18_n and performs ON/OFF controls and abnormality monitoring of the power supply units 11_1 to 11_n (the main power supplies 12_1 to 12_n). The DC/DC converting section 31 is provided in the main

control section 30, converts the DC voltage supply V_c (the DC voltage supplies V_{c1} to V_{cn}) supplied from the control power supply units 15_1 to 15_n into a predetermined value of DC voltage supply, and supplies this to each section of the main control section 30.

In the structure described above, the AC voltage source V_{AC} supplied to the feeder terminal TA_1 is converted into the DC voltage supply V_{A1}, the DC voltage supply V_{B1}, and the DC voltage supply V_{c1} by the control power supply unit 15_1. These DC voltage supplies V_{A1}, V_{B1}, and V_{c1} are supplied to the main power supply control section 13_1, the unit side control section 17_1, and the DC/DC converting section 31. With this, the main power supply control section 13_1, the unit side control section 17_1, and the main control section 30 become in operable states. At this time, it is supposed that the AC/DC converting function of the main power supply unit 12_1 is in an OFF state, and the DC voltage supply V_{DC1} is not outputted from the main power supply unit 12_1.

Similar operations to that of the power supply units 11_1 are performed in the power supply units 11_2 (now shown) to 11_n, at the same time as the operation described above. That is, the AC voltage source V_{AC} supplied to the feeder terminal TA_n is converted into the DC voltage supply V_{An}, the DC voltage supply V_{Bn}, and the DC voltage supply V_{Cn} by the control power supply unit 15_n. These DC voltage supplies V_{An}, V_{Bn}, and V_{Cn} are

supplied to the main power supply control section 13_n, the unit side control section 17_n, and the main control section 30 (the DC/DC converting section 31). With this, the main power supply control section 13_n and the unit side control section 17_n become in the operable state. At this time it is supposed that the AC/DC converting function of the main power supply unit 12_n is in an OFF state, and the DC voltage supply V_{DCn} is not outputted from the main power supply unit 12_n. The main control section 30 is already made operable.

When a start switch (not shown) of the main control section 30 is pressed down, an ON signal is transmitted from the main control section 30 to the respective unit side control sections 17_1 to 17_n via the interfaces 18_1 to 18_n in accordance with a predetermined sequence. When the ON signal is received, the unit side control section 17_1 transmits the ON signal to the main power supply control section 13_1. When receiving this ON signal, the main power supply control section 13_1 turns the AC/DC converting function of the main power supply unit 12_1 on. With this the main power supply unit 12_1 converts the AC voltage source V_{AC} supplied to the feeder terminal TA_1 into the DC voltage supply $V_{DC}1$ and then supplies this to the load 20 via the diode 14_1 and the cable (not shown).

Similar operations to that of the power supply units 11_1 is performed in the power supply units 11_2 (now shown) to 11_n, parallel to the operation of the power supply units 11_1. That

is, when the ON signal from the main control section 30 is received, the unit side control section 17_n transmits the ON signal to the main power supply control section 13_n. When receiving this ON signal, the main power supply control section 13_n turns the AC/DC converting function of the main power supply unit 12_n on. With this the main power supply unit 12_n converts the AC voltage source V_{AC} supplied to the feeder terminal TA_n into the DC voltage supply V_{DCn} and then supplies this to the load 20 via the diode 14_n and the cable (not shown).

When abnormality occurs in the main power supply unit 12_1 and the output of the DC voltage supply V_{DC1} from the main power supply unit 12_1 is stopped, the main power supply control section 13_1 transmits the abnormality detection signal to the unit side control section 17_1. When receiving this abnormality detection signal, the unit side control section 17_1 transmits the abnormality detection signal to the main control section 30 via the interface 18_1. When receiving the abnormality detection signal, the main control section 30 generates a main abnormality alarm showing that abnormality has occurred in the main power supply unit 12_1.

Next, another structural example of a conventional power supply device will be explained referring to Fig. 6. Fig. 6 is a block diagram showing the structure of a conventional power supply device 40. In this drawing, like reference numerals are attached to the sections corresponding to the

respective sections of Fig. 5. In Fig. 6, external control power supply units 50_1 and 50_2, a feeder terminal TB_1, and a feeder terminal TB_2 are newly provided, and power supply units 41_1 to 41_n are provided as substitutes for the power supply units 11_1 to 11_n shown in Fig. 5.

The external control power supply unit 50_1 converts the AC voltage source V_{AC} supplied to the feeder terminal TB_1 into a DC voltage supply V_{G1} and supplies this to a control system including the unit side control sections 17_1 to 17_n and the DC/DC converting section 31 of the main control section 30 (the main control section 30) via a cable (not shown). This external control power supply unit 50_1 is composed of an AC/DC converting section 51_1 converting the AC voltage source V_{AC} into the DC voltage supply V_{G1} and a diode 52_1 provided in the downstream side of the AC/DC converting section 51_1. This diode 52_1 is an element for preventing a rush current.

The external control power supply unit 50_2 is juxtaposed with the external control power supply unit 50_1, converts the AC voltage source V_{AC} supplied to the feeder terminal TB_2 into a DC voltage supply V_{G2}, and supplies this to the control system including the unit side control sections 17_1 to 17_n and the DC/DC converting section 31 (the main control section 30) via a cable (not shown). This external control power supply unit 50_2 is composed of an AC/DC converting section 51_2 converting the AC voltage source V_{AC} into the DC voltage supply V_{G2} and

a diode 52_2 provided in the downstream side of the AC/DC converting section 51_2. This diode 52_2 is an element for preventing a rush current.

These external control power supplies 50_1 and 50_2 are constituted as a parallel redundancy structure. Accordingly, even when the DC voltage supply output from one of the external control power supplies 50_1 and 50_2 is stopped, stable supply of the DC voltage supply to the unit side control sections 17_1 to 17_n and the main control section 30 is performed by the other.

In the power supply unit 41_1, a rush current prevention circuit 42_1 is an element provided in the downstream side of the unit side control section 17_1 and preventing a rush current from flowing in the unit side control section 17_1 when the power supply unit 41_1 is inserted in a slot of an information processor. The DC voltage supply V_{G1} and the DC voltage supply V_{G2} from the external control power supply units 50_1 and 50_2 are supplied to the unit side control section 17_1 via a cable (not shown) and the rush current prevention circuit 42_1 as a DC voltage supply V_{B1}.

In the power supply unit 41_n, a rush current prevention circuit 42_n is an element provided in the downstream side of the unit side control section 17_n and preventing a rush current from flowing in the unit side control section 17_n when the power supply unit 41_n is inserted in a slot of the information processor. The DC voltage supply V_{G1} and the DC voltage supply

V_{G2} from the external control power supplies 50_1 and 50_2 are supplied to the unit side control section 17_n via a cable (not shown) and the rush current prevention circuit 42_n as a DC voltage supply V_{Bn}. The DC voltage supply V_{G1} and the DC voltage supply V_{G2} from the external control power supplies 50_1 and 50_2 are supplied to the DC/DC converting section 31 of the main control section 30 via a cable (not shown) as a DC voltage supply V_C.

In the structure described above, the AC voltage source V_{AC} supplied to the feeder terminal TA_1 is converted into a DC voltage supply V_{A1} by a control power supply unit 15_1. This DC voltage supply V_{A1} is supplied to the main power supply control section 13_1. With this, the main power supply control section 13_1 becomes in the operable state. At this time, it is supposed that the AC/DC converting function of the main power supply unit 12_1 is in an OFF state, and the DC voltage supply V_{DC1} is not outputted from the main power supply unit 12_1.

Similar operations to that of the power supply units 41_1 are performed in the power supply units 41_2 (now shown) to 41_n, at the same time as the operation described above. That is, the AC voltage source V_{AC} supplied to the feeder terminal TA_n is converted into a DC voltage supply V_{An} by the control power supply unit 15_n. This DC voltage supply V_{An} is supplied to the main power supply control section 13_n. With this, the main

power supply control section 13_n becomes in the operable state. At this time, it is supposed that the AC/DC converting function of the main power supply unit 12_n is in an OFF state, and the DC voltage supply V_{DCn} is not outputted from the main power supply unit 12_n.

The AC voltage source V_{AC} supplied to the feeder terminal TB_1 is converted into the DC voltage supply V_{G1} by the AC/DC converting section 51_1 of the external control power supply unit 50_1, at the same time as the operations of the control power supplies 15_1 to 15_n described above. Similarly, the AC voltage source V_{AC} supplied to the feeder terminal TB_2 is converted into the DC voltage supply V_{G2} by the AC/DC converting section 51_2 of the external control power supply unit 50_2.

The DC voltage supplies V_{G1} and V_{G2} are supplied to the DC/DC converting section 31 of the main control section 30 via the diodes 52_1 and 52_2 and the cables (not shown) as the DC voltage supply V_c. With this, the main control section 30 becomes in the operable state. Further, the DC voltage supplies V_{G1} and V_{G2} are supplied to the unit side control sections 17_1 to 17_n via the diodes 52_1 and 52_2, the cables (not shown), and the rush current prevention circuits 42_1 to 42_n as the DC voltage supplies V_{B1} to V_{Bn}. With this, the unit side control sections 17_1 to 17_n become in the operable state.

When a start switch (not shown) of the main control section 30 is pressed down, an ON signal is transmitted from

the main control section 30 to the respective unit side control sections 17_1 to 17_n via the interfaces 18_1 to 18_n in accordance with a predetermined sequence. With this, through the operations described above, the DC voltage supplies V_{DC1} to V_{DCn} are outputted from the main power supplies 12_1 to 12_n. These DC voltage supplies V_{DC1} to V_{DCn} are supplied to the load 20 as the DC voltage supply V_{DC}.

Here, when abnormality occurs in the control power supply unit 15_1, the unit side control section 17_1 becomes in the communication abnormality state in which communication is impossible with the main power supply control section 13_1. At this time since being supplied the DC voltage supplies V_{G1} and V_{G2} from the external control power supplies 50_1 and 50_2, the unit side control section 17_1 is in an operable state regardless of abnormality of the control power supply unit 15_1. When detecting the communication abnormality, the unit side control section 17_1 transmits an abnormality detection signal showing that abnormality has occurred inside the power supply units 41_1 to the main control section 30 via the interface 18_1. When receiving this abnormality detection signal, the main control section 30 generates a power supply unit abnormality alarm showing that abnormality has occurred in the power supply units 41_1.

Since the conventional power supply 10 shown in Fig. 5 is constituted so as to supply the DC voltage supplies to both

of the main power supply control section 13_1 and the unit side control section 17_1 from one control power supply unit 15_1 inside the power supply units 11_1 as described above, for example, when the control power supply unit 15_1 fails, both functions of the main power supply control section 13_1 and the unit side control section 17_1 stop simultaneously.

Accordingly, in this case, since the abnormality detection signal is not outputted from the unit side control section 17_1 to the main control section 30, an extremely serious problem from a maintenance point of view occurs in which abnormality in the power supply units 11_1 cannot totally be recognized in the main control section 30.

On the other hand, since the power supply device 40 shown in Fig. 6 is constituted so as to supply the DC voltage supplies individually to the main power supply control section 13_1 and the unit side control section 17_1 by the dual circuits power supply including the external control power supplies 50_1 and 50_2 and the control power supply unit 15_1, the problem such as that of the power supply 10 described above does not occur.

However, since the power supply device 40 is constituted in such a manner that the external control power supplies 50_1 and 50_2 are separately provided for the power supply units 41_1 to 41_n, the number of power supplies increases compared with that of the power supply 10 and extra space and cables are needed, thereby resulting in the problem that the device costs more.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a power supply device by which the cost can be reduced and the reliability can be enhanced.

In order to attain the above described object, the invention according to first aspect is characterized in a power supply device comprising a plurality of power supply units (corresponding to power supply units 101_1 to 101_n of a first embodiment described later) each comprising a main power supply unit (corresponding to main power supply units 12_1 to 12_n of the first embodiment described later) generating a load voltage to be supplied to a load, a control unit (corresponding to unit side control sections 17_1 to 17_n of the first embodiment described later) informing the outside of the result of abnormality monitoring of each section, and a control power supply unit (corresponding to control power supply units 15_1 to 15_n of the first embodiment described later) generating a controlling voltage to be supplied to the control unit, said power supply units being constituted as a parallel redundancy structure, wherein each said control unit in the plural power supply units is parallel connected to the control power supply units in other power supply units in addition to the control power supply unit in the power supply unit thereof.

According to this invention, the load voltages are supplied from each main power supply unit in the plural power

supply units to the load. The controlling voltages are supplied from each control power supply unit in the plural power supply units to the control unit. Paying attention to the control unit in one power supply unit, the control unit not only receives the supply of the controlling voltage from the control power supply unit in the power supply unit thereof but also receives the supplies of the controlling voltages from the control power supplies in other power supply units.

Even when abnormality occurs in the control power supply unit in the power supply unit thereof and the output of the controlling voltage from this control power supply unit stops, the controlling voltages are supplied from the control power supplies in other power supply units to the control unit of the power supply unit thereof. That is, this control unit continues the normal operation thereof regardless of the abnormality of the control power supply unit in the power supply unit thereof. Therefore, this control unit detects the abnormality in the power supply unit thereof and informs the outside of this monitoring result.

As described above, since the invention according to first aspect is constituted in such a manner that the controlling voltages are parallel supplied not only from the control power supply unit in the power supply unit thereof but also from the control power supply units in other power supply units to the control unit in the power supply unit thereof,

even when abnormality occurs in the control power supply unit in the power supply unit thereof, the control unit in question can receive the supplies of the controlling voltages from the control power supply units in other power supply units so as to inform the outside of the abnormality in the power supply unit thereof, thereby enabling the enhancement of the reliability.

Further, since the invention according to first aspect is constituted in such a manner that the controlling voltages as a backup is supplied from the control power supply units in other power supply units to the control unit in the power supply unit thereof, the number of power supplies and the number of cables can be reduced compared with the case in which control power supplies are separately provided in the outside as in the prior art, thereby enabling the reduction of the cost.

The invention according to second aspect is characterized in that the power supply of first aspect further comprises converting unit (corresponding to DC/DC converting sections 202_1 to 202_n of a second embodiment described later) being inserted in the upstream side of the control unit, converting the inputted controlling voltage into a constant controlling voltage, and supplying the controlling voltage to the control unit.

According to this invention, the load voltages are supplied from each main power supply unit in the plural power

supply units to the load. The controlling voltages are supplied from each control power supply unit in the plural power supply units to the control unit via the converting unit. Paying attention to the control unit in one power supply unit, the control unit not only receives the supply of the controlling voltage from the control power supply unit in the power supply unit thereof but also receives the supplies of the controlling voltages from the control power supply units in other power supply units.

Even when abnormality occurs in the control power supply unit in the power supply unit thereof and the output of the controlling voltage from this control power supply unit stops, the controlling voltages are supplied from the control power supply units in other power supply units to the control unit of the power supply unit thereof via the converting unit. At this time the converting unit converts the inputted controlling voltages into the constant controlling voltage and supplies this to the control unit.

Thus, even when a line drop is generated between the control unit in the power supply unit thereof and the control unit in other power supply units, the constant controlling voltage is always supplied to the control unit in the power supply unit thereof without being influenced by the line drop. That is, this control unit continues its normal operation regardless of the abnormality of the control power supply unit

in the power supply unit thereof. Therefore, this control unit detects the abnormality in the power supply unit thereof and informs the outside of this monitoring result.

As described above, since the invention according to second aspect is constituted in such a manner that the converting unit is provided to compensate for the line drop so that the constant controlling voltage is always supplied to the control unit, the reliability can be further enhanced.

The invention according to third aspect is characterized in that the power supply of first or second aspects further comprises rush current prevention unit (corresponding to diodes 14_1 to 14_n, diodes 16_1 to 16_n, and rush current prevention circuits 102_1 to 102_n of the first and second embodiments described later) being provided in each downstream side of the main power supply unit, the control power supply unit, and the control unit so as to prevent a rush current from flowing in.

Since this invention is constituted in such a manner that the flowing of a rush current into the power supply units is prevented even when the power supply units are hot-line connected by providing the rush current prevention unit, hot-line maintenance can safely be executed.

The invention according to fourth aspect is characterized in a power supply comprising a power supply unit comprising a main power supply unit generating a load voltage to be supplied to a load, a control unit informing the outside

of the result of abnormality monitoring of each section, and a control power supply unit generating a controlling voltage to be supplied to the control unit, said power supply unit constituting part of a parallel redundancy structure along with other power supply units, wherein said control unit is parallel connected to the control power supplies in the other power supply units in addition to the control power supply unit of the power supply unit thereof.

Since this invention is constituted in such a manner that the controlling voltages are parallel supplied to the control unit in the power supply unit thereof not only from the control power supply unit in the power supply unit thereof but also from the control power supplies in other power supply units, even when abnormality occurs in the control power supply unit in the power supply unit thereof, this control unit can receive the supplies of the controlling voltages from the control power supplies in other power supply units so as to inform the outside of the abnormality in the power supply unit thereof, thereby enabling the enhancement of the reliability.

Further, since this invention is constituted in such a manner that the controlling voltages as a backup is supplied from the control power supply units in other power supply units to the control unit in the power supply unit thereof, the number of power supplies and the number of cables can be reduced compared with the case in which control power supply units are

separately provided in the outside as in the prior art, thereby enabling the reduction of the cost.

The invention according to fifth aspect is characterized in a power supply comprising a power supply unit comprising a control unit informing the outside of the result of abnormality monitoring of each section and a control power supply unit generating a controlling voltage to be supplied to the control unit, said power supply unit constituting part of a parallel redundancy structure along with other power supply units, wherein said control unit is parallel connected to the control power supply units in the other power supply units in addition to the control power supply unit of the power supply unit thereof.

Since this invention is constituted in such a manner that the controlling voltages are parallel supplied to the control unit in the power supply unit thereof not only from the control power supply unit in the power supply unit thereof but also from the control power supplies in other power supply units, even when abnormality occurs in the control power supply unit in the power supply unit thereof, this control unit can receive the supplies of the controlling voltages from the control power supplies in other power supply units so as to inform the outside of the abnormality in the power supply unit thereof, thereby enabling the enhancement of the reliability.

Further, since this invention is constituted in such a

manner that the controlling voltages as a backup is supplied from the control power supply units in other power supply units to the control unit in the power supply unit thereof, the number of power supplies and the number of cables can be reduced compared with the case in which control power supply units are separately provided in the outside as in the prior art, thereby enabling the reduction of the cost.

Other objects and features of this invention will become understood from the following description with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a block diagram showing the structure of a first embodiment according to the present invention.

Fig. 2 is a block diagram showing the structure of a second embodiment according to the present invention.

Fig. 3 is a circuit diagram showing a concrete structure of the second embodiment.

Fig. 4 is a view showing voltage characteristics in the second embodiment.

Fig. 5 is a block diagram showing the structure of the conventional power supply 10.

Fig. 6 is a block diagram showing the structure of the conventional power supply device 40.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In the below, first embodiment and second embodiment according to the present invention will be explained in detail referring to drawings.

Fig. 1 is a block diagram showing the structure of the first embodiment according to the present invention. In a power supply 100 shown in this drawing, like reference numerals are attached to the sections corresponding to the respective sections of Fig. 5. In Fig. 1, power supply units 101_1 to 101_n are provided as substitutes for the power supply units 11_1 to 11_n shown in Fig. 5, and rush current prevention circuits 102_1 to 102_n are newly provided.

In the power supply unit 101_1, the rush current prevention circuit 102_1 is an element inserted between the cathode of a diode 16_1 and the unit side control section 17_1 and preventing a rush current from flowing in the unit side control section 17_1 when the power supply unit 101_1 is inserted in a slot of an information processor (whose drawing is omitted).

A DC voltage supply is supplied to the unit side control section 17_1 via dual feeder paths of a feeder path L_{11} and a backup feeder path L_{12}. That is, a DC voltage supplies $V_{B1}$from the control power supply unit 15_1 is supplied to the unit side control section 17_1 via the feeder path L_{11} (the diode 16_1). When the control power supply unit 15_1 fails and feeding via

the feeder path L_{11} stops, a backup DC voltage supply V_{B1}' from a control power supply units 15_2 (not shown) to 15_n is supplied to the unit side control section 17_1 via the backup feeder path L_{12} instead of the feeder path L_{11}.

In the power supply unit 101_n, the rush current prevention circuit 102_n is an element inserted between the cathode of a diode 16_n and the unit side control section 17_n similarly to the rush current prevention circuit 102_1 and preventing a rush current from flowing in the unit side control section 17_n when the power supply unit 101_n is inserted in a slot of the information processor.

A DC voltage supply is supplied to the unit side control section 17_n via dual feeder paths of a feeder path L_{n1} and a backup feeder path L_{n2}. That is, a DC voltage supplies V_{Bn} from a control power supply unit 15_n is supplied to the unit side control section 17_n via the feeder path L_{n1} (the diode 16_n).

When the control power supply unit 15_n fails and feeding via the feeder path L_{n1} stops, a backup DC voltage supply V_{Bn}' from the control power supply units 15_1 to 15_{n-1} (not shown) is supplied to the unit side control section 17_n via the backup feeder path L_{n2} instead of the feeder path L_{n1}. Each structure of the power supply units 101_2 to 101_{n-1} (whose drawings are omitted) are the same as the structure of the power supply unit 101_1 and the power supply unit 101_n described above.

In the structure described above, the AC voltage source

V_{AC} supplied to the feeder terminal TA_1 is converted into a DC voltage supply V_{A1}, a DC voltage supply V_{B1}, and a DC voltage supply V_{C1} by the control power supply unit 15_1. These DC voltage supplies V_{A1} and V_{C1} are supplied to the main power supply control section 13_1 and the DC/DC converting section 31. With this, the main power supply control section 13_1 and the main control section 30 become in the operable state.

The DC voltage supply V_{B1} from the control power supply unit 15_1 is supplied to the unit side control section 17_1 via the rush current prevention circuit 102_1 through the feeder path L_{11}. At this time, it is supposed that an AC/DC converting function of the main power supply unit 12_1 is in an OFF state, and the DC voltage supply V_{DC1} is not outputted from the main power supply unit 12_1.

Similar operations to that of the power supply units 101_1 are also performed in the power supply units 101_2 (now shown) to 101_n, at the same time as the operation described above. That is, the AC voltage source V_{AC} supplied to the feeder terminal TA_n is converted into a DC voltage supply V_{An}, a DC voltage supply V_{Bn}, and a DC voltage supply V_{Cn} by the control power supply unit 15_n. These DC voltage supplies V_{An} and V_{cn} are supplied to the main power supply control section 13_n and the DC/DC converting section 31.

With this, the main power supply control section 13_n and the main control section 30 becomes in the operable state. The

DC voltage supply V_{Bn} from the control power supply unit 15_n is supplied to the unit side control section 17_n via the rush current prevention circuit 102_n through the feeder path L_{n1}. At this time, it is supposed that the AC/DC converting function of the main power supply unit 12_n is in an OFF state and the DC voltage supply V_{DCn} is not outputted from the main power supply unit 12_n.

When a start switch (not shown) of the main control section 30 is pressed down, an ON signal is transmitted from the main control section 30 to the respective unit side control sections 17_1 to 17_n via the interfaces 18_1 to 18_n in accordance with a predetermined sequence. When the ON signal is received, the unit side control section 17_1 transmits the ON signal to the main power supply control section 13_1. When receiving this ON signal, the main power supply control section 13_1 turns the AC/DC converting function of the main power supply unit 12_1 on. With this the main power supply unit 12_1 converts the AC voltage source V_{AC} supplied to the feeder terminal TA_1 into the DC voltage supply V_{DC1} and then supplies this to the load 20 via the diode 14_1 and the cable (not shown).

Similar operations to that of the power supply units 101_1 are also performed in the power supply units 101_2 (now shown) to 101_n, at the same time as the operation of the power supply unit 101_1. That is, when the ON signal from the main control section 30 is received, the unit side control section 17_n

transmits the ON signal to the main power supply control section 13_n. When receiving this ON signal, the main power supply control section 13_n turns the AC/DC converting function of the main power supply unit 12_n on. With this the main power supply unit 12_n converts the AC voltage source V_{AC} supplied to the feeder terminal TA_n into the DC voltage supply V_{DCn} and then supplies this to the load 20 via the diode 14_n and the cable (not shown).

When abnormality occurs in the control power supply unit 15_1, feeding the DC voltage supply from the control power supply unit 15_1 to the main power supply control section 13_1 and the unit side control section 17_1 stops. At this time the backup DC voltage supply V_{B1}' from the control power supply units 15_2 (not shown) to 15_n is supplied to the unit side control section 17_1 via the backup feeder path L_{12} instead of the feeder path L_{11}. Thus, the unit side control section 17_1 continues its normal operation regardless of the abnormality of the control power supply unit 15_1.

The unit side control section 17_1 may become in a communication abnormality state in which it cannot communicate with the main power supply control section 13_1. With this the unit side control section 17_1 transmits an abnormality detection signal showing that abnormality has occurred inside the power supply units 101_1 to the main control section 30 via the interface 18_1. When receiving this abnormality detection

signal, the main control section 30 generates a power supply unit abnormality alarm showing that abnormality has occurred in the power supply units 101_1.

As explained above, since the first embodiment is constituted in such a manner that the backup DC voltage supply V_{B1}' is parallel supplied to the unit side control section 17_1 from the control power supply units 15_2 (not shown) to 15_n in other power supply units 101_2 to 101_n in addition to the DC voltage supply V_{B1} from the control power supply unit 15_1 in the power supply unit thereof (e.g., the power supply unit 101_1), even when abnormality occurs in the control power supply unit 15_1, the unit side control section 17_1 can receive the supply of the backup DC voltage supply V_{B1} from other control power supply units 15_2 to 15_n so as to inform the outside of abnormality in the power supply unit 101_1. Thus, the reliability can be enhanced.

Further, according to the present invention regarding the first embodiment, since the number of power supplies and the number of cables can be reduced compared with the case in which the external control power supply units 50_1 and 50_2 are separately provided in the outside as in the conventional power supply 40 (refer to Fig. 6), the cost can be reduced.

Moreover, since the first embodiment is constituted in such a manner that the flowing of a rush current into the power supply units 101_1 to 101_n is prevented even when the power supply

units 101_1 to 101_n are hot-line connected by providing the diodes 14_1 to 14_n, the diodes 16_1 to 16_n, and the rush current prevention circuits 102_1 to 102_n, hot-line maintenance can safely be executed.

Fig. 2 is a block diagram showing the structure of the second embodiment according to the present invention. Fig. 3 is a circuit diagram showing a concrete structure of the second embodiment. In a power supply device 200 shown in these drawings, like reference numerals are attached to the sections corresponding to the respective sections of Fig. 1. In Fig. 2, power supply units 201_1 to 201_n and control power supplies 203_1 to 203_n are provided as substitutes for the power supply units 101_1 to 101_n and the control power supplies 15_1 to 15_n shown in Fig. 1, and DC/DC converting sections 202_1 to 202_n are newly provided.

The main power supply unit 12_1 shown in Fig. 3 comprises a diode bridge circuit 209 full-wave rectifying the AC voltage source V_{AC}, a choking coil 210, a switching element 211 switchingly controlled by an ON/OFF control section 220 described later so as to improve the power factor, a smoothing capacitor 212, a diode 213, and a transformer 214. A switching element 215 is inserted in a primary side coil 214a of the transformer 214 so as to stabilize the DC voltage supply V_{DC1}. A rectifying-smoothing circuit composed of diodes 216, 217, a choking coil 218, and a smoothing capacitor 219 is connected

in a secondary side coil 214b of the transformer 214.

In the main power supply control section 13_1, the ON/OFF control section 220, 221 ON/OFF control the switching element 211, 215 based on an ON/OFF control signal from the unit side control section 17_1 described later. A voltage abnormality monitor circuit 222 is a circuit for monitoring voltage abnormality, such as an overvoltage and a low voltage, based on the result of a comparison between a reference DC voltage supply of a reference dc power supply 223 and the DC voltage supply V_{DC1}. This voltage abnormality monitor circuit 222 transmits an abnormality detection signal to an MPU (Micro Processing Unit) 240 of the unit side control section 17_1 as the monitor result when detecting voltage abnormality.

A control power supply unit 203_1 is inserted between the main power supply unit 12_1 and the DC/DC converting section 31 and has a DC/DC converting function for converting a DC voltage supply V_{D1} into predetermined values of DC voltage supply V_{A1} and DC voltage supply V_{C1}, respectively, taking the voltage between terminals of the smoothing capacitor 212 of the main power supply unit 12_1 (the DC voltage supply V_{D1}may be, for example, 380 volts) as an input. This control power supply unit 203_1 has a transformer 224 with a primary coil 224a, secondary coils 224b, 224c. In this primary coil 224a, a switching element 225 is inserted for stabilizing the DC voltage supply V_{A1} and the DC voltage supply V_{C1}. This switching

element 225 is ON/OFF controlled by an ON/OFF control section 226.

A rectifying-smoothing circuit composed of a diode 227 and a smoothing capacitor 228 is connected in the secondary coil 224b. The DC voltage supply V_{A1} from this rectifying-smoothing circuit is supplied to each section of the main power supply control section 13_1. A rectifying-smoothing circuit composed of a diode 229 and a smoothing capacitor 230 is connected in the secondary coil 224c. The DC voltage supply V_{C1} from this rectifying-smoothing circuit is supplied to the DC/DC converting section 31 (the main control section 30) via the diode 16_1.

A voltage abnormality monitor circuit 242 is a circuit for monitoring voltage abnormality, such as an overvoltage and a low voltage, based on the result of a comparison between a reference DC voltage supply of a reference dc power supply 243 and the DC voltage supply V_{C1}. This voltage abnormality monitor circuit 242 transmits an abnormality detection signal to the MPU 240 of the unit side control section 17_1 as the monitor result when detecting voltage abnormality.

The rush current prevention circuit 102_1 is composed of resistances 231 to 234, a capacitor 235, and a switching element 236 and restrains a rush current in such a manner that the switching element 236 is ON/OFF controlled by the time constant of the resistances 231 to 234 and the capacitor 235.

The DC/DC converting section 202_1 has a DC/DC converting function in which the DC voltage supply V_{B1} or the backup DC voltage supply V_{B1}' inputted are converted into a constant value of constant DC voltage supply V_{IN1} as shown in Fig. 4. The constant DC voltage supply V_{IN1} is the operation guarantee voltage of the unit side control section 17_1 and is, for example, 5 volts. The DC/DC converting sections 202_1 is composed of capacitors 237, 238 and a regulator 239, and this regulator 239 is a power supply element for stabilizing the constant DC voltage supply V_{IN1}.

The unit side control section 17_1 is connected to the main control section 30 via the interface 18_1 and works as a communication interface between the main power supply control section 13_1 and the main control section 30. This unit side control section 17_1 is composed of the MPU 240 and an interface control section 241.

Concretely, the interface control section 241 receives the ON/OFF control signal from the main control section 30 via the interface 18_1 and sends it to the MPU 240. The MPU 240 transmits the ON/OFF control signal to the ON/OFF control sections 220, 221 of the main power supply control section 13_1. The MPU 240 receives the abnormality detection signal from the voltage abnormality monitor circuits 222, 242 of the main power supply control section 13_1 and sends this to the interface control section 241. The interface control section 241

transmits the abnormality detection signal to the main control section 30 via the interface 18_1.

Similarly, in the power supply unit 201_n, the DC/DC converting section 202_n converts the inputted DC voltage supply V_{Bn} or backup DC voltage supply V_{Bn}' into a constant value of constant DC voltage supply V_{Inn} as shown in Fig. 4. The constant DC voltage supply V_{Inn} is the operation guarantee voltage of the unit side control section 17_n and is, for example, 5 volts. The control power supply unit 203_n is inserted between the main power supply unit 12_n and the DC/DC converting section 31 and has the DC/DC converting function for converting a DC voltage supply V_{Dn} from the main power supply unit 12_n (e.g., 380 volts) into predetermined values of DC voltage supply V_{An} and DC voltage supply V_{Cn}, respectively, taking the DC voltage supply V_{Dn} as an input. The detailed structures of each section of the power supply unit 201_n are the same as the detailed structures of each section of the power supply unit 201_1 described above.

In the structure described above, the AC voltage source V_{AC} fed to the feeder terminal TA_1 shown in Fig. 2 is converted into the DC voltage supply V_{A1}, the DC voltage supply V_{B1}, and the DC voltage supply V_{C1} by the control power supply unit 203_1. These the DC voltage supplies V_{A1} and V_{C1} are supplied to the main power supply control section 13_1 and the DC/DC converting section 31. With this the main power supply control section

13_1 and the main control section 30 become in the operable state.

The DC voltage supply V_{B1} from the control power supply unit 203_1 is supplied to the DC/DC converting section 202_1 via the rush current prevention circuit 102_1 through the feeder path L_{11}. Here, the line drop in the feeder path L_{11} is approximately zero volts since the path length is short. The DC voltage supply V_{B1} is supposed to be 8 volts shown in Fig. 4. The DC voltage supply V_{B1} is converted into 5 volts of constant DC voltage supply V_{IN1} shown in Fig. 4 by means of the DC/DC converting section 202_1. Since this constant DC voltage supply V_{IN1} is supplied to the unit side control section 17_1, the unit side control section 17_1 becomes in the operable state. At this time, it is supposed that the AC/DC converting function of the main power supply unit 12_1 is in the OFF state, and the DC voltage supply V_{DC1} is not outputted from the main power supply unit 12_1.

Similar operations to that of the power supply units 201_1 are performed in the power supply units 201_2 (now shown) to 201_n, at the same time as the operation described above. The AC voltage source V_{AC} supplied to the feeder terminal TA_n is converted into the DC voltage supply V_{An}, the DC voltage supply V_{Bn}, and the DC voltage supply V_{Cn} by the control power supply unit 203_n. These DC voltage supplies V_{An} and V_{Cn} are supplied to the main power supply control section 13_n and the DC/DC

converting section 31. With this, the main power supply control section 13_n and the main control section 30 become in the operable state.

The DC voltage supply V_{Bn} from the control power supply unit 203_n is supplied to the DC/DC converting section 202_n via the rush current prevention circuit 102_n through the feeder path L_{n1}. Here, the line drop in the feeder path L_{n1} is approximately zero volts since the path length is short. The DC voltage supply V_{Bn} is supposed to be 8 volts shown in Fig. 4. The DC voltage supply V_{Bn} is converted into 5 volts of constant DC voltage supply V_{INn} shown in Fig. 4 by means of the DC/DC converting section 202_n. Since this constant DC voltage supply V_{Inn} is supplied to the unit side control section 17_n, the unit side control section 17_n becomes in the operable state. At this time, it is supposed that the AC/DC converting function of the main power supply unit 12_n is in the OFF state and the DC voltage supply V_{DCn} is not outputted from the main power supply unit 12_n.

When a start switch (not shown) of the main control section 30 is pressed down, an ON signal is transmitted from the main control section 30 to the respective unit side control sections 17_1 to 17_n via the interfaces 18_1 to 18_n in accordance with a predetermined sequence. With this, through the operations described above, the DC voltage supplies V_{DC1} to V_{DCn} are outputted from the main power supply units 12_1 to 12_n. These

DC voltage supplies V_{DC1} to V_{DCn} are supplied to the load 20 as the DC voltage supplies V_{DC}.

Here, when abnormality occurs in the control power supply unit 203_1 at the time t_1 shown in Fig. 4, feeding the DC voltage supply from the control power supply unit 203_1 to the main power supply control section 13_1 and the unit side control section 17_1 stops. At this time the backup DC voltage supply V_{B1}' from a control power supply units 203_2 (not shown) to 203_n is supplied to the DC/DC converting section 202_1 via the backup feeder path L_{12} instead of the feeder path L_{11}. When the backup feeder path L_{12} (cable length) is long, a line drop V_L is generated in this backup feeder path L_{12}. Therefore, the backup DC voltage supply V_{B1}' decreases by the line drop V_L than the DC voltage supply V_{Bn}(the DC voltage supply V_{B1}) as shown in Fig. 4.

However, the backup DC voltage supply V_{B1}' is converted into 5 volts of constant DC voltage supply V_{IN1} shown in Fig. 4 by means of the DC/DC converting section 202_1 regardless of the line drop V_L. That is, the DC/DC converting section 202_1 performs a voltage compensation for the line drop V_L. Thus, a constant (5 volts) DC voltage supply V_{IN1} shown in Fig. 4 is constantly supplied to the unit side control section 17_1 regardless of abnormality of the control power supply unit 203_1.

The unit side control section 17_1 may become in the

communication abnormality state in which communication is impossible with the main power supply control section 13_1. With this the unit side control section 17_1 transmits an abnormality detection signal showing that abnormality has occurred inside the power supply unit 201_1 to the main control section 30 via the interface 18_1. When receiving this abnormality detection signal, the main control section 30 generates a power supply unit abnormality alarm showing that abnormality has occurred in the power supply units 201_1.

As explained above, since the second embodiment is constituted in such a manner that the DC/DC converting sections 202_1 to 202_n are provided to compensate for line drops so that the constant DC voltage supplies V_{IN1} to V_{Inn} are always supplied to the unit side control sections 17_1 to 17_n, the reliability can be further enhanced.

In the above, although the first and second embodiments according to the present invention are explained in detail referring to drawings, concrete structural examples are not limited to these first and second embodiments, and design alteration or the like without departing from the gist of the present invention will be included in the present invention. For example, although the power supplies having the AC/DC converting function are explained in the first and second embodiments, the power supplies may have an AC-AC converting function, a DC-AC converting function, or a DC/DC converting

function.

As explained above, since a power supply device according to the present invention is constituted in such a manner that the controlling voltages are parallel supplied not only from the control power supply unit in the power supply unit thereof but also from the control power supply units in other power supply units to the control means in the power supply unit thereof, even when abnormality occurs in the control power supply unit in the power supply unit thereof, the control means can receive the supplies of the controlling voltages from the control power supply units in the other power supply units so as to inform the outside of the abnormality in the power supply unit thereof, thereby producing the effect that the reliability can be enhanced.

Since a power supply device according to the present invention is constituted in such a manner that the controlling voltages as a backup are supplied from the control power supply units in other power supply units to the control means in the power supply unit thereof, the number of power supplies and the number of cables can be reduced compared with the case in which control power supplies are separately provided in the outside as in the prior art, thereby producing the effect that the cost can be reduced.

A power supply according to the present invention is constituted in such a manner that the converting means is

provided to compensate for a line drop so that a constant controlling voltage is always supplied to the control means, thereby producing the effect that the reliability can be further enhanced.

A power supply according to the present invention is constituted in such a manner that a rush current prevention means is provided so as to prevent a rush current from flowing in the power supply unit even when the power supply unit is hot-line connected, thereby producing the effect that hot-line maintenance can safely be executed.

Although the invention has been described with respect to a specific embodiment for a complete and clear disclosure, the appended claims are not to be thus limited but are to be construed as embodying all modifications and alternative constructions that may occur to one skilled in the art which fairly fall within the basic teaching herein set forth.